A Low Power, Solid State, Method of Oxygen Supply

Completed Technology Project (2016 - 2017)

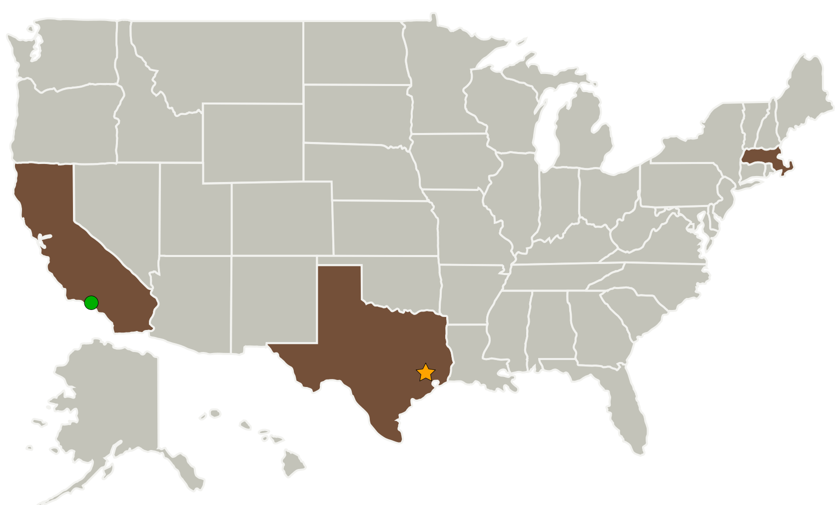
Project Introduction

The key innovation of the work prior to the start of this project is the planar monolith - allowing for solid state oxygen production at pressures up to 300 psig. The key innovation of this proposed work is a new method of cell stack thermal management - with the key objective of reducing power use by more than 50% compared to current SOA. This thermal management approach is entirely new - it has not been used by any NASA, Industry, or academic project for oxygen separation. After the first year's work to develop and demonstrate a TRL 4 engineering prototype, next step is to develop and manufacture a fully packaged and integrated system suitable for flight demonstration on ISS.

Anticipated Benefits

Ceramic Transport Membranes can produce oxygen from air at high purity, at high pressure, using solid state processes. CTMs are not in widespread use because 1) the technology is new, and 2) in its current state it uses more power than other approaches. This project intends to replace the single-pass process air loop with a recirculating process air loop. The innovation: uncoupling fresh air intake from convective temperature control. The achievement: projected power use 1.4 Whr / liter of O2. The goal: to build and demonstrate a high purity (>99.99% O2) oxygen supply capable of providing suit recharge oxygen, contingency ECLS oxygen, or emergency medical oxygen - with power efficiency 63% better than the State of the Art, and unprecedented reliability that only solid state systems can achieve.

Primary U.S. Work Locations and Key Partners



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Center Innovation Fund: JSC CIF

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Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
Massachusetts Institute of Technology(MIT)	Supporting Organization	Academia	Cambridge, Massachusetts

Primary U.S. Work Locations	
California	Massachusetts
Texas	

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

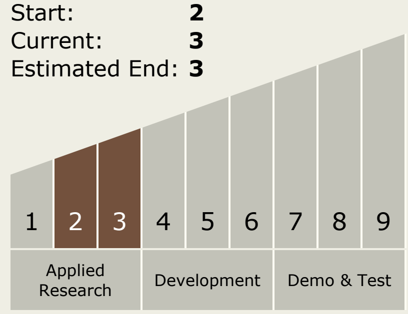
Carlos H Westhelle

Principal Investigator:

John C Graf

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



July 2017: Closed out

Closeout Summary: *The analytical results related to cell stack electrical resista nce and thermal management were similar to sizing estimates made at the start of the project. But these analytical results could not be experimentally confirme d. The cell stack intended for use for this project was damaged during shipping from White Sands Test Facility to Johnson Space Center. A replacement cell sta ck is on order, and the plan is for the experimental work to continue – under the sponsorship of Advanced Exploration Systems (AES). AES has agreed to sponso r continued development in this project. Primary technical results that are supp orted with experimental data are in the area of improved heat recovery in the pr ocess air flow loop. Three different process air heat recovery systems were desi gned: 1) a single, coiled path, tube-in-tube heat exchanger, 2) a compact shell i n tube heat exchanger with 300 tubular elements, and 3) a folded path shell in t ube heat exchanger with 5 tubular elements. Surface area, system pressure dro p, system manufacturability, system size, thermal efficiency, thermal environme nts, and material compatibility were assessed in a system trade. The folded pat h, 5 element, air to air heat exchanger was selected for prototype construction a nd testing. A solid model of the folded path design is shown below: note the lo w pressure manifold detail, the open flow paths for low system pressure drop, a nd favorable system shape factor. System test results show better than expecte d system pressure drop attributes, and successful high temperature operational performance. Minor redesign efforts are underway to address flow channeling is sues that were identified during testing.*

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - └─ TX14.2 Thermal Control Components and Systems
    - └─ TX14.2.3 Heat Rejection and Storage

Target Destinations

Earth, The Moon, Mars

Supported Mission Type

Projected Mission (Pull)